Comparison of the male genitalia and androconia of *Pseudochazara anthelea acamanthis* (Rebel, 1916) from Cyprus, *Pseudochazara anthelea anthelea* (Hübner, 1824) from mainland Turkey and *Pseudochazara anthelea amalthea* (Frivaldsky, 1845) from mainland Greece (Nymphalidae, Satyrinae)

Andrew Wakeham-Dawson[1], Rob Parker[2], Eddie John[3] & Roger L. H. Dennis[4]

[1] The International Commission on Zoological Nomenclature, c/o The Natural History Museum, Cromwell Road, London, SW7 5BD, Great Britain (e-mail: andrw@nhm.ac.uk); corresponding author
[2] 66 Cornfield Road, Bury St Edmunds, Suffolk, IP33 3BN, Great Britain
[3] Davies Cottage, Penllyn, Cowbridge, Vale of Glamorgan, CF71 7RQ, Great Britain
[4] Department of Entomology, The Manchester Museum, Manchester University, Oxford Road, Manchester, M13 9PL, Great Britain

Summary. Statistical analysis of measurements made on genitalia and androconia of *Pseudochazara anthelea acamanthis* (Rebel, 1916) butterflies from Cyprus, *P. anthelea anthelea* (Hübner, 1924) from mainland Turkey and *P. anthelea amalthea* (Frivaldsky, 1845) from mainland Greece shows that there is considerable overlap between the three taxa as represented by the specimens used in this study. The general similarity of the genitalia and androconia of these specimens supports Olivier's (1996) synonymy of *P. anthelea acamanthis* with *P. anthelea anthelea* based on his study of wing pattern.

K e y w o r d s . Lepidoptera, Satyrinae, *Pseudochazara anthelea*, genitalia, androconia, Cyprus, Greece, Turkey, biometrics, statistical analysis.

Introduction

The genus *Pseudochazara* de Lesse, 1951 (type-species by original designation *Hipparchia pelopea* Klug, 1832) consists of over twenty species and subspecies that are restricted to Europe and Asia. Gross (1978) reviewed the genus, but recent discovery of additional species means that a fresh revision is now necessary and preliminary work towards such a revision is underway (Wakeham-Dawson & Kudrna 2000; Wakeham-Dawson & Dennis 2001). As noted by Gross (1978), Hesselbarth et al. (1995) and Wakeham-Dawson & Dennis (2001), *Pseudochazara* species can be divided into two subgroups: (1) those that have male genitalia and androconia that are broadly similar to the type species *P. pelopea* and (2) those that have male genitalia and androconia that are broadly similar to *P. anthelea anthelea* (Hübner, 1824). It is intended that these two groups be formally described as subgenera in the planned revision.

The *P. anthelea anthelea*-subgroup is represented in the area around the Aegean Sea by a number of nominal subspecies. Olivier (1996) concluded, on the basis of wing pattern examination, that the nominal subspecies *Pseudochazara anthelea*

acamanthis (Rebel, 1916) from Cyprus is conspecific with *P. anthelea anthelea* (Hübner, 1824) from mainland Turkey. However, he did not consider male genitalia or androconia in his deliberations. In continuation of a long-running study of the butterflies of Cyprus (Parker 1983, John 2000) and as part of the revision of the genus *Pseudochazara* mentioned above, measurements made on androconia and genitalia from specimens of *P. anthelea acamanthis* from Cyprus are compared in the current study with measurements made on specimens of *P. anthelea anthelea* from mainland Turkey. This paper presents the results of an analysis of these measurements and comments on the relationship between mainland and Cyprus populations (subspecies). It also compares these findings with androconia and genitalia measurements from specimens of *P. anthelea amalthea* (Frivaldsky, 1845) captured in mainland Greece and areas just north of Greece.

Methods

Sources of data and measurements.The genitalia and androconia measurement data used in the current study are taken from 60 male *Pseudochazara* butterfly specimens: 23 *P. anthelea acamanthis*, 20 *P. anthelea anthelea* and 17 *P. anthelea amalthea*. The locations in which these specimens were captured are provided in the Appendix.

The genitalia have been measured using the methods described in Wakeham-Dawson & Dennis (2001) and the androconia using methods described in Wakeham-Dawson & Kudrna (2000) (also see Figs. 1-3), although in the current study androconia were mounted under cover slips in DPX medium on microscope slides, rather than being preserved dry under the cover slips (as in Wakeham-Dawson & Kudrna 2000). Diago-

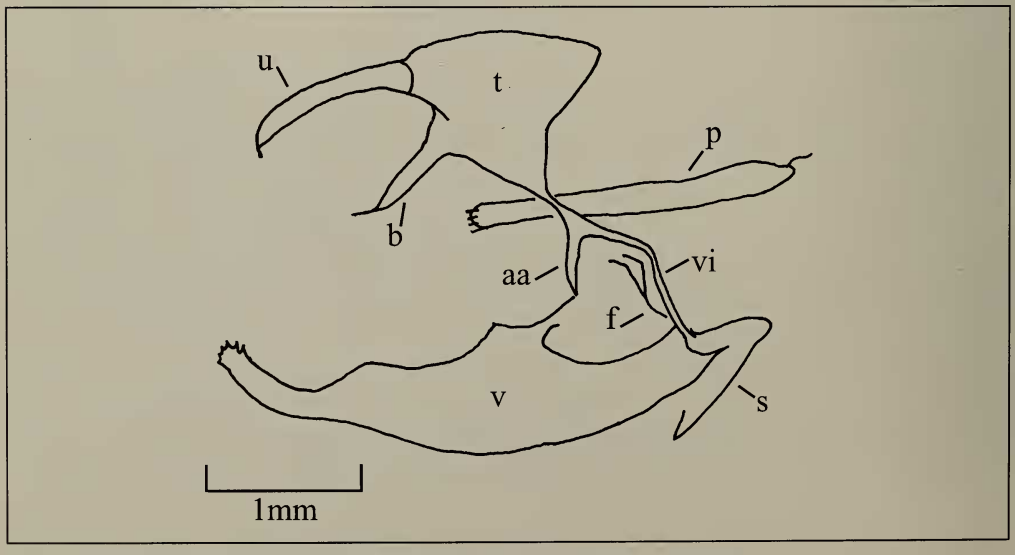

Fig. 1. Diagram of male genitalia of *Pseudochazara anthelea* subspecies. aa = apex angularis; b = brachium; f = furca; p = penis; s = saccus; t = tegumen; u = uncus; v = valve; vi = vinculum. Terminology after Higgins (1975).

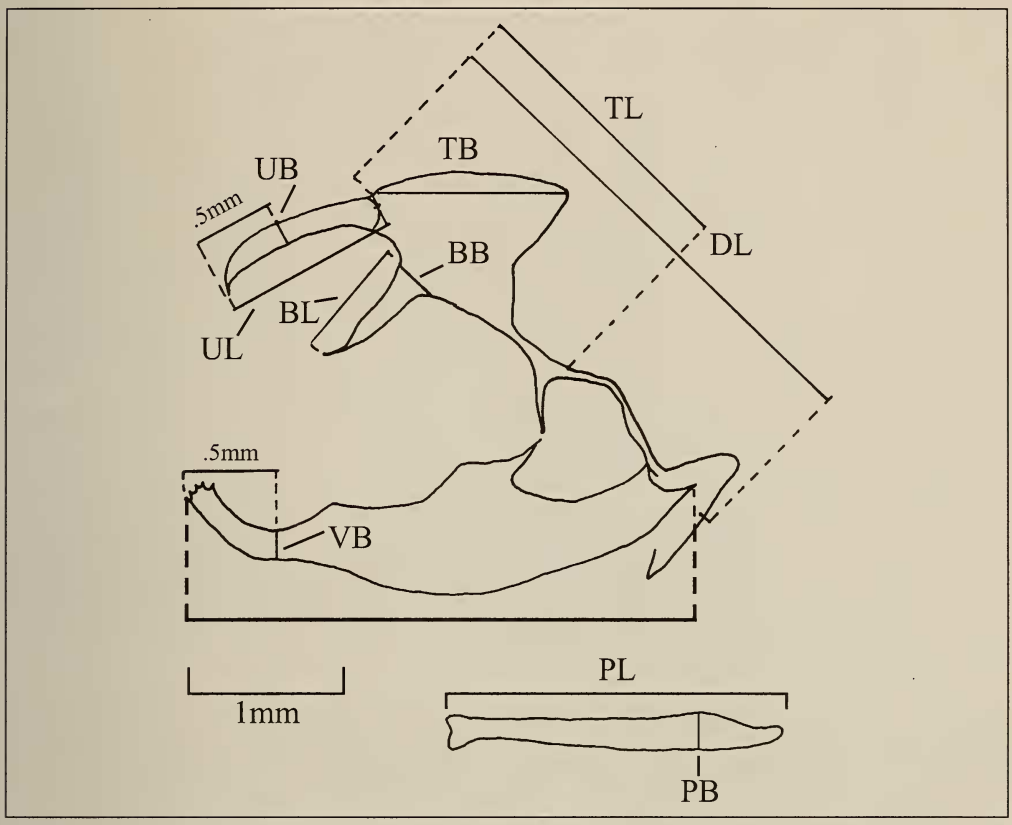

Fig. 2. Diagram of measurements made on male genitalia of *Pseudochazara anthelea* subspecies. DL = diagonal length, measured from dorsal junction of tegumen and uncus to base of saccus (the line running at the same angle as the vinculum); VL (indicated by the solid line running beneath the valve) = valve length; VB = valve breadth, measured at 0.5 mm from valve apex and at 90° to the line VL; UL = uncus length, measured from uncus apex to mid-point between junction of tegumen and uncus; UB = uncus breadth, measured at 0.5 mm from uncus apex and at 90° to the line UL; BL = brachium length, measured from apex of brachium to dorsal junction of tegumen and brachium; BB = brachium breadth, measured across junction of tegumen and brachium; TL = tegumen length, measured from dorsal junction of tegumen and uncus to junction of apex angularis and vinculum; TB = tegumen breadth; PL = penis length; PB = maximum penis breadth.

nal length (DL) is divided by valve length (VL) to produce a unit-less ratio *D*, which measures overall proportion (shape) of the genitalia independently of size variation between individuals in a taxon. Similarly, valve length (VL) is divided by valve breadth (VB) to produce a ratio *V*, representing valve shape. Uncus length (UL) is divided by uncus breadth (UB) to produce a ratio *U*, representing uncus shape. Brachium length (BL) is divided by brachium breadth (BB) to produce a ratio *B*, representing brachium shape. Tegumen length (TL) is divided by tegumen breadth (TB) to give a ratio *T*, representing tegumen shape, and penis length (PL) is divided by uncus breadth (UB) (as penis breadth, PB, is not available for all specimens) to give a ratio *P1*. In addition, penis length (PL) is divided by penis breadth (PB) (with linear regression estimates of PB for thirteen specimens; $r = 0.67$, $F_{3, 42} = 11.59$, $p < 0.00001$) to give a ratio *P2*.

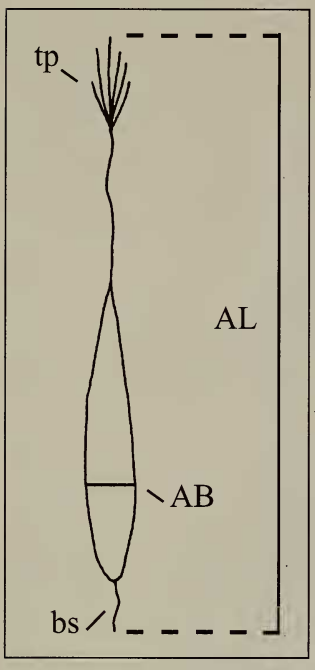

Fig. 3. Diagram of *Pseudochazara anthelea* androconium and the measurements made. AL = androconium length, measured from basal stalk (bs) to terminal points (tp) at apex; AB = androconium breadth, measured across widest part of androconium. Terminology after Kudrna (1977).

Androconium length (AL) is divided by androconium breadth (AB) to give ratio *A*. This provides 21 variables (13 measurements and 8 ratios) for analysis.

Statistical analysis. All variables, with the exception of BB, are normally distributed. These variables are analysed untransformed. BB shows a positive skew and is treated with a $\log_{10}$ transformation before analysis. Data are analysed using one-way analysis of variance (ANOVA), stepwise discriminant function analysis (DFA) and Euclidean non-metric multi-dimensional scaling (NMMS) (see Sneath & Sokal 1973; Statsoft 1999). These methods have been shown to be effective in revealing morphological relationships between taxa (e.g. Wakeham-Dawson & Dennis 2001).

Results

The means, standard errors and maximum and minimum values of measurements and ratios from genitalia (Fig. 2) and androconia (Figs. 3 & 4) of all three taxa are presented for comparison in Tables 1 (measurements) and 2 (ratios). Only five of the 13 measurements (VL, UL, $\log_{10}$ BB, TB, PL) reveal significant differences ($p<0.05$) between the taxa, with PB marginally significant at $p=0.06$, when ANOVA is applied (Table 3). For the eight ratios, only three (*U*, *B* and *P1*) show significant differences when ANOVA is applied (Table 4).

In these cases, the taxonomic pattern is similar in all variables, except for the comparison of BB and ratio *B* (brachium length, BL, divided by brachium breadth, BB). *P. anthelea acamanthis* is distinct from *P. anthelea anthelea* (significant differences, $p<0.05$, shown in all variables except *B*) and *P. anthelea amalthea* (significant differ-

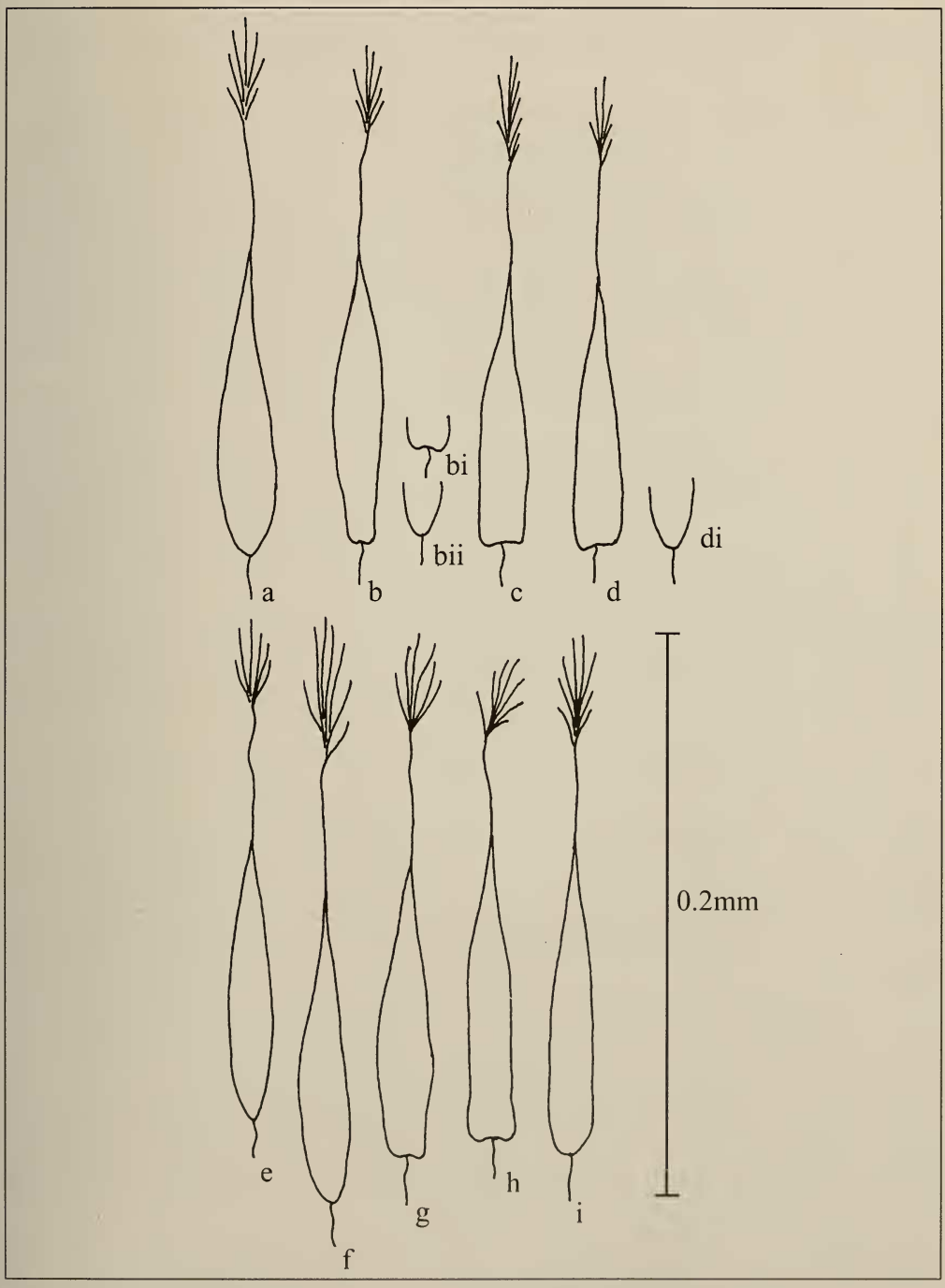

Fig 4. The androconia of *P. anthelea anthelea* from mainland Turkey [specimen nos. 443 (diagram a), 345 (b, bi, bii), 444 (c), 192 (d, di)] and *P. anthelea acamanthis* from Cyprus [specimen nos. 437 (diagram e), 439 (f), 438 (g), 436 (h), 435 (i)]. Note the variation in androconium base shape both within and between specimens. The androconia of *P. anthelea amalthea* (not illustrated) are similar in shape and show similar variation in base shape to those illustrated. There is no significant difference in the shape of the androconia between any of these taxa (see Tables 3 & 4).

Tab. 1. Summary statistics (means, standard errors (SE) and minimum (Min) and maximum (Max)) values for genital and androconial variables in three taxa of *Pseudochazara* butterflies (measurements in mm). N = number of specimens. See text for explanation.

Taxon	*Pseudochazara anthelea acamanthis*					*Pseudochazara anthelea anthelea*					*Pseudochazara anthelea amalthea*				
Variable	N	Mean	Min	Max	SE	N	Mean	Min	Max	SE	N	Mean	Min	Max	SE
VL	23	3.036	2.700	3.320	0.036	20	3.248	2.700	3.560	0.047	17	3.221	3.000	3.540	0.044
VB	23	0.220	0.160	0.320	0.008	20	0.210	0.160	0.270	0.007	17	0.222	0.130	0.350	0.015
UL	22	1.219	1.040	1.330	0.014	20	1.314	1.050	1.480	0.023	17	1.326	1.200	1.440	0.016
UB	23	0.128	0.100	0.160	0.003	20	0.123	0.100	0.140	0.002	17	0.126	0.100	0.150	0.004
BL	23	0.841	0.720	1.000	0.015	20	0.874	0.800	1.000	0.012	17	0.860	0.750	0.960	0.012
BB	23	0.272	0.240	0.340	0.005	20	0.301	0.240	0.400	0.009	17	0.331	0.280	0.450	0.011
DL	23	3.053	2.880	3.320	0.025	20	3.186	2.750	3.360	0.038	17	3.077	2.280	3.520	0.083
TL	23	1.752	1.550	1.860	0.019	20	1.735	1.350	2.100	0.045	17	1.806	1.600	2.080	0.033
TB	23	1.456	1.300	1.600	0.017	20	1.516	1.350	1.660	0.023	16	1.544	1.330	1.680	0.021
PL	23	2.327	2.160	2.560	0.021	20	2.447	2.200	2.700	0.035	16	2.541	2.320	2.800	0.032
PB	23	0.253	0.220	0.280	0.003	17	0.267	0.240	0.300	0.005	7	0.260	0.240	0.280	0.006
AL	23	0.194	0.177	0.217	0.002	19	0.197	0.168	0.227	0.003	15	0.199	0.186	0.226	0.003
AB	23	0.017	0.014	0.023	0.001	19	0.019	0.013	0.033	0.001	15	0.017	0.012	0.022	0.001

Tab. 2. Summary statistics (means, standard errors (SE) and minimum (Min) and maximum (Max)) for genital and androconial ratios in three taxa of *Pseudochazara* butterflies (no units). N = number of specimens. See text for explanation.

Taxon	*Pseudochazara anthelea acamanthis*				*Pseudochazara anthelea anthelea*				*Pseudochazara anthelea amalthea*			
Variable	Mean	Min	Max	SE	Mean	Min	Max	SE	Mean	Min	Max	SE
V	14.21	9.37	19.00	0.556	15.94	10.80	21.00	0.719	15.75	8.71	24.08	1.213
U	9.62	6.50	12.00	0.272	10.76	8.75	12.80	0.222	10.68	8.33	13.00	0.392
B	3.12	2.38	3.85	0.071	2.95	2.20	3.57	0.087	2.65	1.89	3.43	0.095
T	1.21	1.10	1.30	0.012	1.15	0.91	1.41	0.032	1.18	0.98	1.33	0.023
P1	18.40	14.38	25.60	0.503	20.06	16.92	22.50	0.395	20.35	16.67	26.30	0.657
P2	9.23	8.00	10.67	0.152	9.26	8.21	10.92	0.139	9.63	8.78	10.61	0.144
D	1.01	0.87	1.09	0.011	0.98	0.92	1.03	0.008	0.96	0.65	1.11	0.028
A	11.40	8.13	14.50	0.313	10.95	5.88	14.23	0.437	11.85	8.68	16.83	0.564

Pseudochazara anthelea acamanthis N= 23, *Pseudochazara anthelea anthelea* N = 20, *Pseudochazara anthelea amalthea* N = 17

Tab. 3. One way analysis of variance (ANOVA) for genital and androconial measurements in three taxa of *Pseudochazara* butterflies. Significant effects ($p<0.05$) printed in **bold face**.

One way ANOVA								
Variable	SS effect	df effect	MS effect	SS error	df error	MS error	F	p
VL	0.5698	2	0.2849	2.0417	57	0.0358	7.95	**0.0009**
VB	0.0016	2	0.0008	0.1145	57	0.0020	0.41	0.67
UL	0.1418	2	0.0709	0.3695	56	0.0066	10.74	**<0.0001**
UB	0.0004	2	0.0002	0.0109	57	0.0002	0.95	0.39
BL	0.0116	2	0.0058	0.2089	57	0.0037	1.58	0.23
BB	0.0037	2	0.0019	0.0087	57	0.0002	12.25	**<0.0001**
DL	0.2039	2	0.1019	2.7122	57	0.0476	2.14	0.13
TL	0.0506	2	0.0253	1.2594	57	0.0221	1.15	0.33
TB	0.0815	2	0.0408	0.4603	56	0.0082	4.96	**0.0104**
PL	0.4427	2	0.2213	0.9436	56	0.0168	13.14	**<0.0001**
PB	0.0019	2	0.0010	0.0136	44	0.0003	3.11	0.06
AL	0.0003	2	0.0001	0.0080	54	0.0001	0.88	0.44
AB	0.0000	2	0.0000	0.0006	54	0.0000	0.98	0.38

ences shown in all variables), but *P. anthelea anthelea* and *P. anthelea amalthea* are homogeneous (only $\log_{10}$ BB and *B* show a significant difference).

In stepwise discriminant function analysis (DFA), only three of the variables (*P1*, $\log_{10}$ BB and UL) are retained that provide significant discrimination between taxa when all three groups (*P. anthelea acamanthis*, *P. anthelea anthelea* and *P. anthelea amalthea*) are compared or when only two groups (*P. anthelea acamanthis* vs. *P. anthelea anthelea*

Tab. 4. One way analysis of variance (ANOVA) for genital and androconial ratios in three taxa of *Pseudochazara* butterflies. Significant effects ($p<0.05$) printed in **bold face**.

Variable	SS effect	df effect	MS effect	SS error	df error	MS error	F	p
V	38.24	2	19.12	753.02	57	13.21	1.447	0.244
U	17.40	2	8.70	97.84	57	1.72	5.068	**0.009**
B	2.16	2	1.08	7.94	57	0.14	7.760	**0.001**
T	0.03	2	0.02	0.60	57	0.01	1.626	0.206
P1	46.34	2	23.17	304.66	57	5.34	4.335	**0.018**
P2	1.74	2	0.87	24.67	57	0.43	2.015	0.143
D	0.02	2	0.01	0.29	57	0.01	2.369	0.103
A	7.56	2	3.78	208.69	57	3.66	1.032	0.363

and *P. anthelea amalthea* amalgamated) are compared. DFA of the three groups gives 70% (18 individuals misclassified) correct classification (Wilks'λ= 0.42, $F_{(6, 110)}$= 9.92, $p<0.0001$). A plot of the first two roots shows that *P. anthelea anthelea* and *P. anthelea amalthea* almost completely overlap. However, *P. anthelea acamanthis* would fall outside these two groups if it were not for five of the *P. anthelea anthelea* specimens and the position of one *P. anthelea acamanthis* specimen (Fig. 5). DFA of the two groups gives 90% (6 individuals misclassified) correct classification (Wilks'λ=0.50, $F_{(3, 56)}$=18.95, $p<0.0001$). This shows good separation, but not enough to avoid confusion in a blind trial.

Two Euclidean non-metric multidimensional scaling (NMMS) plots based on all variables and just on ratios are virtually identical and show that there is considerable overlap between the *P. anthelea acamanthis*, *P. anthelea anthelea* and *P. anthelea amalthea* specimens (Fig. 6 for all variables).

Discussion

Comparison of genitalia and androconia morphology between populations. Analysis of variance shows that *P. anthelea acamanthis* specimens differ significantly from the two mainland taxa specimens (*P. anthelea anthelea* and *P. anthelea amalthea*) in a number of variables. Similarly, *P. anthelea acamanthis* specimens are largely distinct from *P. anthelea anthelea* and *P. anthelea amalthea* in DFA axes. However, Euclidean plots show considerable overlap between the three taxa as represented by the specimens used in this study. The general similarity of the genitalia and androconia of these specimens supports Olivier's (1996) synonymy of *P. anthelea acamanthis* with *P. anthelea anthelea* based on his study of wing pattern. Perhaps more surprising is the apparent similarity between *P. anthelea anthelea* and *P. anthelea amalthea*. However, the similarity between these two taxa has been noted previously by Wakeham-Dawson & Dennis (2001), and although these taxa are treated as distinct species by many authors (e.g. Kudrna 2002), they may in fact be conspecific (i.e. capable of interbreeding to produce fertile offspring). The differences

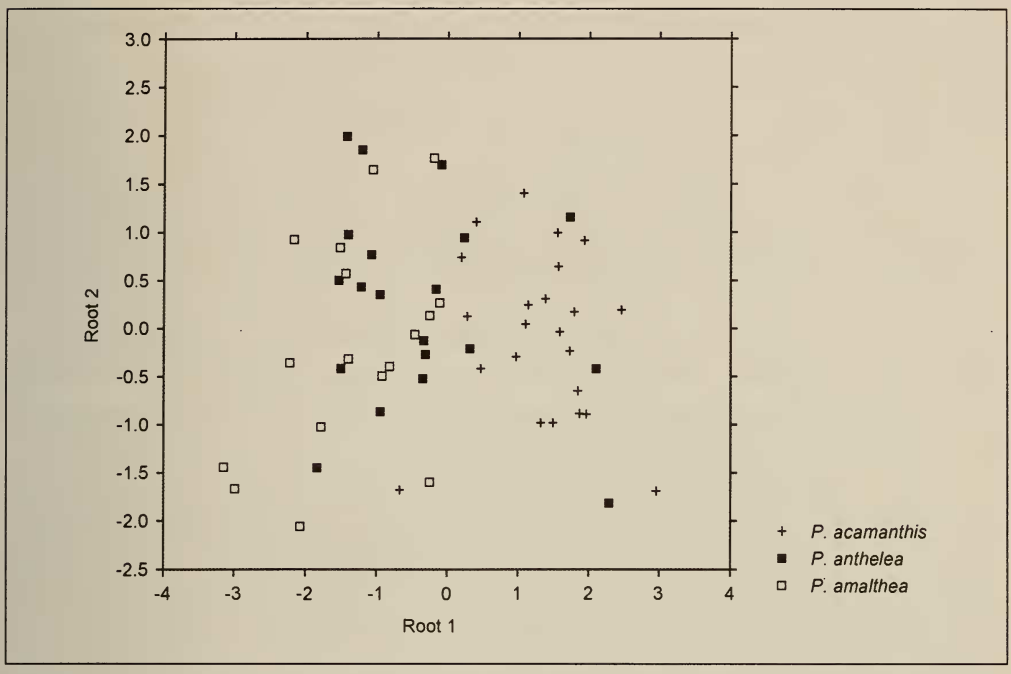

Fig. 5. Plot of three *Pseudochazara anthelea* taxa in the first two roots (Root 1 vs. Root 2) of a discriminant function analysis (DFA).

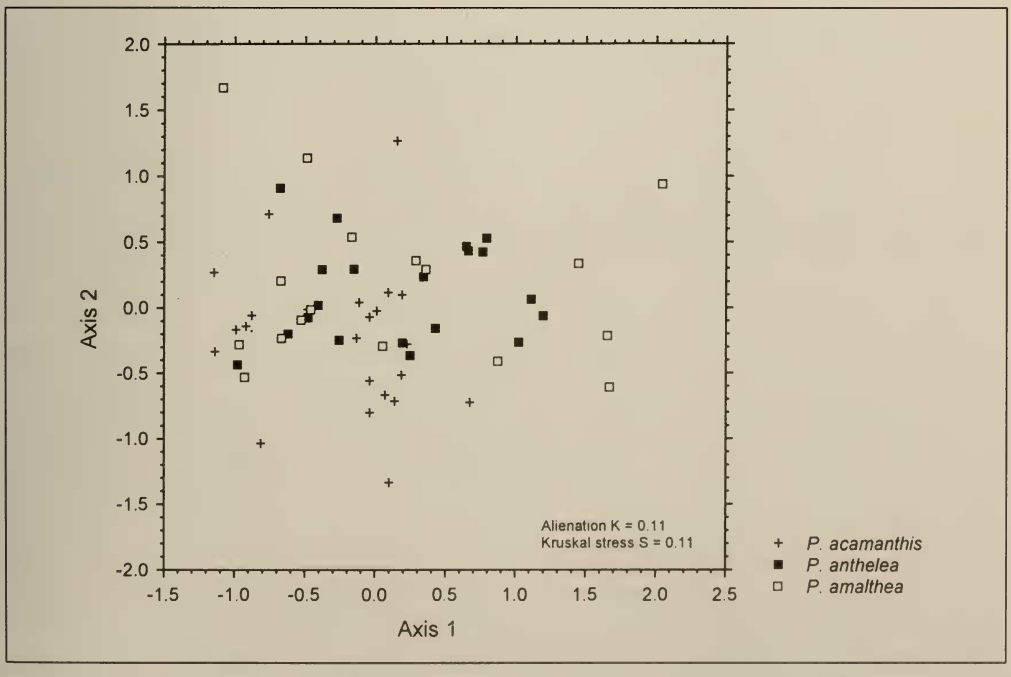

Fig. 6. Non-metric two-dimensional plot (Axis 1 vs. Axis 2) of three *Pseudochazara anthelea* taxa based on Euclidean distances for all genitalia and androconia variables.

between *P. anthelea acamanthis* and *P. anthelea anthelea* and *P. anthelea amalthea*, and the similarities between *P. anthelea anthelea* and *P. anthelea amalthea* indicated by the current small-scale study suggest that a larger study including more specimens and use of molecular data could provide some revealing insights into the relationships between these nominal taxa.

Gene flow between populations. Geological evidence suggests that formation of the island of Cyprus began between 230 and 95 million years ago as it was forced up from the bed of the now Mediterranean Sea by movement of tectonic plates. 'A land area of some sort has existed on the present site of the island from Middle Miocene (about ten million years ago) times onwards' (Greensmith 1998, p.6). As a result, the formation of the island almost certainly pre-dates the formation of the taxa we know as subspecies of *P. anthelea.* The population on Cyprus was probably established by individuals immigrating from the mainland in the last million or so years (although the actual age of these taxa can only be guessed at). The most suitable opportunities for migration would have been during the climate changes, lower sea levels and extended shorelines associated with ice-sheet formation between the Last Glacial Maximum and the early Holocene (Zonnerveld 1995; Lambeck & Bard 2000).

As Cyprus is only 70 km from mainland Turkey, the island population has probably been sporadically augmented in the past with individuals from the mainland, and vice versa. However, *P. anthelea acamanthis* is nowadays the most sedentary of the Cyprus Satyrinae in terms of its vertical distribution. *Hipparchia cypriensis* (Holik, 1949) (another member of the Satyrinae present on Cyprus) has been observed engaging in seasonally reversed migration between sea level and 1900 m (John & Parker 2002). However, *P. anthelea acamanthis* does not show this type of behaviour. It is most frequently encountered *above* 1000 m (Makris in press; R. Parker & E. John, unpublished data) and although it does occur at intermediate elevations, only one specimen (an individual nectaring on *Lantana*) has been recorded from as low as 250 m (D. Haines, unpublished data). It is therefore hard to envisage specimens of the present day *P. anthelea acamanthis* dispersing in numbers from higher elevations. It is even harder to contemplate the species embarking on a crossing to the mainland or vice versa.

This view is supported by an analysis of nearly 300 sightings of *P. anthelea anthelea* recorded in Hesselbarth et al. (1995). On the Turkish mainland, only three specimens (1% of sightings) are listed as being noted below an altitude of 250 m while, in sharp contrast, 282 (96%) were found above 500 m (including 237 records (81%) observed at 1000 m or higher). Changes in climate or agricultural practices may have influenced behaviour in recent centuries, confining the species to generally higher elevations. Although the population on Cyprus may have previously been in reproductive contact with mainland populations, it appears to be effectively isolated at present.

As there are only slight differences between the genitalia and androconia morphology in the island (*P. anthelea acamanthis*) and Turkish mainland (*P. anthelea anthelea*) populations, it would appear that gene flow probably did occur in the past between the two populations. For similar reasons, it would also appear that there is or, until recently, has been regular gene flow between mainland Greece (*P. anthelea amalthea*)

and mainland Turkey (*P. anthelea anthelea*) populations. On the other hand, there may have been only limited evolutionary divergence between the various *P. anthelea anthelea* populations since they became isolated. If this is the case, limited differentiation may be a result of the similarity of the biotopes of the populations in Turkey, Greece and Cyprus (see below). It is worth noting that although *P. anthelea amalthea* and *P. anthelea anthelea* differ in wing colour (especially in the females) this probably does not indicate reproductive isolation between these nominal taxa, as wing colour appears not to be a reliable taxonomic character in the genus *Pseudochazara* (Wakeham-Dawson & Dennis 2001).

Comparison of biotopes between populations. The biotopes of *Pseudochazara anthelea* populations, both on the Turkish mainland and in Cyprus, appear to be very similar, with favoured areas comprising open, rocky ground on steep, mainly south-facing, calcareous hillsides. On Cyprus, sparse vegetation (predominantly *Cistus creticus*, *Arbutus andrachne* and other evergreen sclerophyllous shrubs scattered among large rocks) completes the picture (Parker 1983, John 2000 and unpublished observations). Although we do not have biotope data for all the specimens measured in the current study, some of the Turkish mainland (*P. anthelea anthelea*) specimens measured in our study were captured in surroundings that are similar to the areas where the Cyprus (*P. anthelea acamanthis*) specimens were found. For example, A. Koçak (personal communication) reported that the specimens (nos. 479-484; see Appendix) he and his wife (M. Kemal) provided for this study were found at 1580 m in openings of *Quercus* woodland on calcareous slopes. The biotope occupied by *P. anthelea amalthea* on mainland Greece is similar to that inhabited by the mainland Turkish and Cyprus populations with the species generally restricted to calcareous forested mountain areas above 1000 m (e.g. specimen nos. 73–75; see Appendix).

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Appendix. Collection data of *Pseudochazara* butterfly specimens (23 *P. anthelea acamanthis*, 20 *P. anthelea anthelea* and 17 *P. anthelea amalthea*) measured in the current study. AWD – collection A. Wakeham-Dawson; EIT – collection U. Eitschberger (Marktleuthen, Germany); BM – Booth Museum, UK; RP – collection R. Parker, UK.

Taxon	no.	Location	Capture date	Altitude	Collector	Collection
acamanthis	435	Platres, Cyprus	25.viii.1975	1120 m	R. Parker	AWD
acamanthis	436	Almyrolivado, Cyprus	7.vii.1996	1600 m	C. Makris	AWD
acamanthis	437	Prodromos Dam, Cyprus	8.viii.1996	1400 m	C. Makris	AWD
acamanthis	438	Trooditissa, Cyprus	28.vi.1975	1380 m	R. Parker	RP
acamanthis	439	Trooditissa, Cyprus	23.vii.1975	1380 m	R. Parker	RP
acamanthis	445	Prodromos Dam, Cyprus	14.vi.2001	1450 m	E. John	AWD
acamanthis	446	Prodromos Dam, Cyprus	14.vi.2001	1450 m	E. John	AWD
acamanthis	447	Trooditissa, Cyprus	13.vi.2001	1380 m	E. John	AWD
acamanthis	448	Trooditissa, Cyprus	13.vi.2001	1380 m	E. John	AWD
acamanthis	449	Foini, Cyprus	10.vi.2001	800 m	C. Makris	AWD
acamanthis	450	Prodromos Dam, Cyprus	14.vi.2001	1450 m	E. John	EIT
acamanthis	451	Prodromos Dam, Cyprus	13.vi.2001	1450 m	E. John	EIT
acamanthis	452	Prodromos Dam, Cyprus	13.vi.2001	1450 m	E. John	EIT
acamanthis	453	Madari, Cyprus	10.vi.2001	1400 m	C. Makris	EIT
acamanthis	454	Madari, Cyprus	10.vi.2001	1400 m	C. Makris	AWD
acamanthis	455	Trooditissa, Cyprus	8.vi.2001	1380 m	E. John	AWD
acamanthis	456	Trooditissa, Cyprus	8.vi.2001	1380 m	E. John	EIT
acamanthis	457	Trooditissa, Cyprus	13.vi.2001	1380 m	E. John	EIT
acamanthis	458	Trooditissa, Cyprus	13.vi.2001	1380 m	E. John	EIT
acamanthis	459	Trooditissa, Cyprus	8.vi.2001	1380 m	E. John	AWD
acamanthis	460	Trooditissa, Cyprus	8.vi.2001	1380 m	E. John	AWD
acamanthis	461	Trooditissa, Cyprus	8.vi.2001	1380 m	E. John	AWD
acamanthis	471	Trooditissa, Cyprus	23.vii.1975	1380 m	R. Parker	AWD
amalthea	68	Mt. Parnassus, Greece	12.vii.1995	1000 m	A.Wakeham-Dawson	AWD
amalthea	70	Peloponnesus, Greece	?	?	D. & S. Howell	AWD
amalthea	71	Peloponnesus, Greece	?	?	D. & S. Howell	AWD
amalthea	72	Peloponnesus, Greece	?	?	D. & S. Howell	AWD
amalthea	73	Mt. Chelmos, Greece	24.vii.1992	1000 m	A.Wakeham-Dawson	AWD
amalthea	74	Mt. Chelmos, Greece	26.vii.1992	1000 m	A.Wakeham-Dawson	AWD
amalthea	75	Mt. Chelmos, Greece	26.vii.1992	1000 m	A.Wakeham-Dawson	AWD
amalthea	346	Mt. Parnassus, Greece	14.vii.1978	1000 m	D. & S. Howell	AWD
amalthea	362	Mt. Parnassus, Greece	8.vii.1973	?	P.W. Cribb	BM
amalthea	363	Mt. Parnassus, Greece	23.vii.1973	?	P.W. Cribb	BM
amalthea	472	Konitsa, Greece	3.vii.1997	?	A.Wakeham-Dawson	AWD
amalthea	473	Pirin, Bulgaria	31.v.1983	?	ex Coll. T. Haez	AWD
amalthea	474	Konitsa, Greece	3.vii.1997	?	A.Wakeham-Dawson	AWD
amalthea	475	Topolka, Macedonia	5.vi.1984	?	Schaider	AWD
amalthea	476	Mt. Smolikas, Greece	18.vii.1995	1700 m	Binter	AWD
amalthea	477	Mt. Chelmos, Greece	10.vi.1992	1200 m	?, ex Coll. O. Kudrna	AWD
amalthea	478	Kalavrita, Greece	18.vi.1991	?	V. Folk	AWD
anthelea	192	Dazkiri, Turkey	26.vii.1980	1500 m	D. & S. Howell	AWD
anthelea	345	Dazkiri, Turkey	26.vii.1980	1500 m	D. & S. Howell	AWD
anthelea	358	Elmadag, Turkey	15.vii.1980	?	P.W. Cribb	BM
anthelea	443	Bayburt, Turkey	?	?	?, ex Coll. O. Kudrna	AWD
anthelea	444	Bayburt, Turkey	?	?	?, ex Coll. O. Kudrna	AWD
anthelea	462	Elazig, Turkey	13-14.vi.1974	700 m	F.J. Gross	EIT
anthelea	463	Ankara, Turkey	19-20.vi.1974	1000 m	F.J. Gross	EIT
anthelea	464	Corum, Turkey	05.viii.1976	1100 m	F.J. Gross	EIT
anthelea	465	Ankara, Turkey	19-20.vi.1974	1000 m	F.J. Gross	EIT
anthelea	466	Elazig, Turkey	13.vi.1974	1200 m	F.J. Gross	EIT
anthelea	467	Erzurum, Turkey	6-13.vii.1998	?	ex Coll. O. Kudrna	AWD
anthelea	468	Erzurum, Turkey	6-13.vii.1998	?	ex Coll. O. Kudrna	AWD
anthelea	469	Erzurum, Turkey	6-13.vii.1998	?	ex Coll. O. Kudrna	AWD
anthelea	470	Erzurum, Turkey	6-13.vii.1998	?	ex Coll. O. Kudrna	AWD
anthelea	479	Kayseri, Turkey	26.vi.2001	1580 m	M. Kemal/A. Kocak	AWD
anthelea	480	Kayseri, Turkey	26.vi.2001	1580 m	M. Kemal/A. Kocak	AWD
anthelea	481	Kayseri, Turkey	26.vi.2001	1580 m	M. Kemal/A. Kocak	AWD
anthelea	482	Kayseri, Turkey	26.vi.2001	1580 m	M. Kemal/A. Kocak	AWD
anthelea	483	Kayseri, Turkey	26.vi.2001	1580 m	M. Kemal/A. Kocak	AWD
anthelea	484	Kayseri, Turkey	26.vi.2001	1580 m	M. Kemal/A. Kocak	AWD